DOCUMENT RESUME

ED 236 057 SO 014 850

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TITLE Climatic Concepts and Regions.
INSTITUTION British Columbia Teacher's Federation, Vancouver.
PUB DATE 82
NOTE 14p.; For related documents, see SO 014 851-852.
PUB TYPE Reference Materials - Geographic Materials (133) -- Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Climate; Concept Teaching; Environmental Influences; *Geographic Regions; *Geography Instruction; Humidity; Learning Activities; *Map Skills; Physical Geography; Secondary Education; Teaching Methods; Temperature; Units of Study; Weather; Wind (Meteorology)
IDENTIFIERS Africa; PF Project

ABSTRACT

Designed for students in grades 7 through 12, this teaching unit presents illustrative resource materials depicting concepts related to climate and geographic regions. Emphasis is on giving students an understanding of climatic elements and factors, not as isolated, disjointed entities, but as a dynamic interplay of forces having a very definite impact on the earth's surface. Climate is thus seen as the key to understanding natural and physical regions. Suggestions for teaching a unit on climate include: (1) using a laboratory approach; (2) making concepts real and personal for the student; (3) making sure all important interconnections are discovered; and (4) using a programmed approach so students can see their step-by-step progress in some logical order of complexity. Unit topics include climatic factor, climatic element, wind and pressure, precipitation, convection, and temperature. Students are required not only to identify climatic regions on a map of Africa but to record their understanding by completing charts and cross-sections. An answer key and notes for student assignment sheets are provided, together with illustrations, charts, and graphs. Although most of the activities are based on maps of Africa, they can be easily adapted to other continents and parts of continents. (LH)

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ED236057

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LA 2041

Climatic Concepts and Regions

by
Dr. Paul F. Thomas

The importance of the regional concept

This unit is intended to elicit skills of deduction, induction, and synthesis. Indeed, although the region is the unique contribution of geography, which distinguishes it from the other social sciences, for our purposes, the region is best regarded as a vehicle for awakening synthetic thinking–something demanded by few other school subjects.

In daily life, regions are important because they constitute units of administration as well as dynamic unique entities. Our various levels of government and their nesting jurisdictions presuppose areas of influence, be they towns, urban regions, provinces, or countries. Because various regions interact, we have resource flows and therefore the need for transportation, trade, and commerce.

A region cannot be managed unless a *boundary* can be drawn around it. Boundaries are necessary to reduce human conflict. Such notions are readily grasped by older students, but younger pupils must discover these generalizations in order for the knowledge to be personal and useful.

Fortunately, numerous examples of regional problems are available from the experience of all children.

Which is your dresser drawer? Which is your sister's?
Why does your backyard have a fence around it?
Why is the oil refinery in an isolated location?
How does your neighborhood differ from Tom's neighborhood?
How did the new highway affect the way Farmer Parsons uses his land?

Climate as a regional factor

The study of large regions leads students to appreciate that local cultural responses, although different from our own, are appropriate to the environment. Of the various environmental influences in an area, *climate* is likely to be the most important. It is a more important factor in determining soil types than is bedrock geology. Climate is also the chief determinant of vegetation types. It also reflects local topographic conditions. All in all, climate is the key to understanding natural or physical regions. Climate, however, does not determine what humans do in a region. It does, however, usually set some practical limits on what humans can and cannot reasonably do. In other words, climate sets a large part of the stage for our cultural and economic activities.

Teaching climate

Granted that the region is a very important concept and that climate is a very important part of regional understanding, but does teaching climate really have to be dull and deadly? A dull, abstract approach to climate is a major factor in discouraging students from studying geography. Here are keys to successful teaching of a unit on climate:

- A laboratory approach, where possible.
- Making the concepts real and personal for the student.
- Making sure that all the important interconnections are discovered.
- A programmed approach, whereby the ideas are itemized into bits so that students can see their step-by-step progress in some logical order of complexity.

Following is a unit on climate developed, tested, and modified over many years of experience. The questions are listed together to facilitate their use as assignment sheets. An answer key and notes are provided, together with illustrations and charts.

Most of the examples chosen are based on Africa, simply because that continent–owing to its symmetry about the equator–has the easiest climatic patterns to contend with.

These same ideas can be easily adapted to other continents and parts of continents. The approach is the same; only the mapping details and examples will differ.

This approach is suitable for students in Grades 7 to 12. Depth of approach will depend on specific classes and their background knowledge.

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UNIT ASSIGNMENT–CLIMATE

Introduction

1. How does climate affect our daily lives? Does climate *determine* what we do? Explain.
2. What is the difference between weather and climate?
3. Explain the difference between climatic *factor* and climatic *element*. List:
   a. the factors that affect climate.
   b. the climatic elements.
4. What five things does a climate graph tell us?

Pressure and winds

5. What is *wind*?
6. Why does air move?
7. What causes differences in air pressure on the earth's surface?
8. What name is given to:
   a. horizontal movement of air?
   b. vertical movement of air?
9. Describe daily experiences and/or experiments to show:
   a. that air occupies space
   b. that air has weight
   c. that air exerts pressure
   d. that hot air rises
   e. that cool air sinks
   f. convection cells
   g. that air contains moisture
   h. that evaporation of a liquid requires heat
10. What name is given to the effects of convection cells on the earth's surface?

Precipitation

11. What does *precipitation* mean?
12. What is the cause of all precipitation?
    a. State three ways this cause can display itself.
    b. Draw labelled diagrams that show and explain the three types of precipitation.
13. Which type of precipitation predominates in _____ (various specified localities)?
    a. in summer?
    b. in the other seasons?
    c. Which type(s) never occur in _____ (various specificed localities)?
    d. Why? (For each of a, b, and c above.)
14. Draw labelled diagrams to show _____'s (for specified region; for example, Africa) *pressures and winds* for northern summer, and northern winter. Indicate implications for precipitation.
15. Enter the following table in your notebook *sideways* and complete it in organized point-phrase form. (For the region under study; for example, Africa.)

FIGURE A

Climatic region	Characteristics Temperature/precipitation	Reasons for these characteristics	Representative station
Hot-wet tropics	All months over 21°C. Rain every month. Annual over 150 mm.	Overhead sun around more or less all year. Therefore, low pressure → convectional rain all year.	Douala, Cameroon See p. ___, Atlas.
Wet-dry tropics Semi-desert Tropical drylands Mediterranean Damp subtropics Warm temperate Tropical highland	(To be treated in manner similar to above.)		

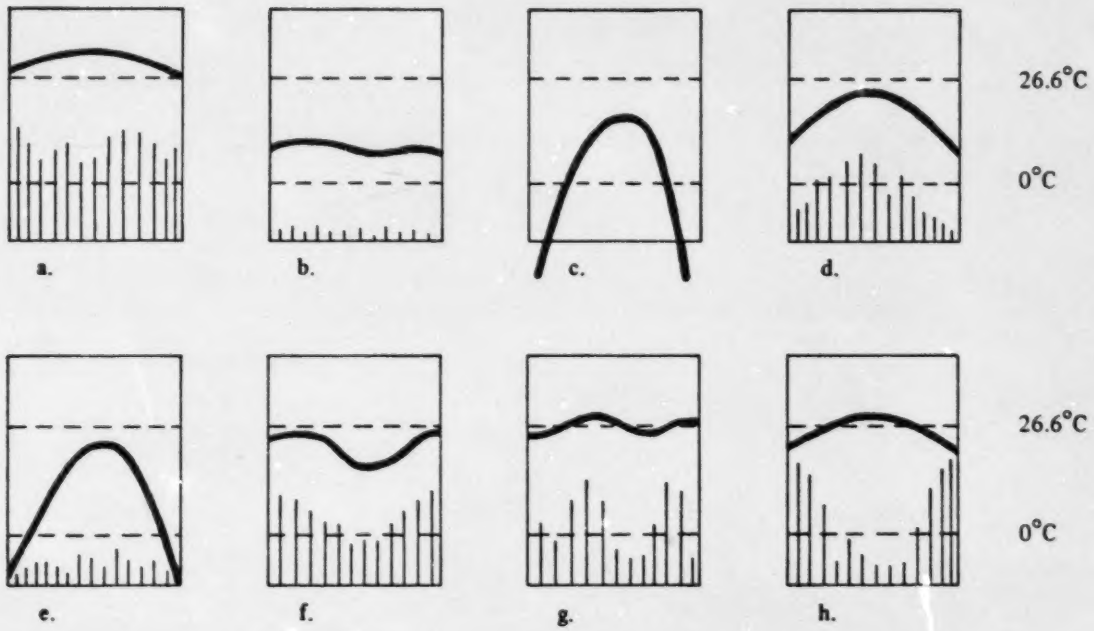
Climate graph recognition

16. Find a climatic station in _____ (the region under study; for example, Africa) that has a graph similar to the following: a. to h. below

Analyze the graphs you have found and account for them in terms of climatic factors.

FIGURE B

Annual temperature and rainfall in each region



17. Match items a. to h. above to the following descriptors:

maritime	Mediterranean: summer dry/winter wet
continental	wet all year; summer maximum
equatorial	southern hemisphere; summer maximum
equatorial, at high altitude	maximum, spring and fall
hot and wet all year	evenly distributed
winter dry/summer wet	extreme continental

Give both *descriptive* and *explanatory* reasons for your answer.

CLIMATE–ANSWER KEY AND NOTES

Introduction

1. Influences of climate in our daily lives:
   - The kinds of clothes we wear.
   - Form and construction of our shelters.
   - Seasonal rhythms of work and play.
   - Range of foods produced and eaten.
   - Forms of transportation, construction, and maintenance problems.

   Have the students provide examples for each of the above points.

2. Both *weather* and *climate* refer to happenings in the same place, namely the atmosphere. *Weather* refers to day-to-day events in the atmosphere. *Climate* refers to the average atmospheric conditions over longer periods of time, such as the seasons.

3. An *element* is an aspect or ingredient of climate:
   - Amount and distribution of precipitation.
   - Levels and changes in temperature.
   - Length of growing season.
   - Patterns of cloudiness and sunshine.
   - Prevailing windspeeds and directions.
   - Humidity levels.

   A *factor* is an influence that determines some aspect(s) of climate. The major influences on climate are latitude; altitude; nearness to, or distance from, water bodies such as oceans or lakes; pressures and prevailing winds; ocean currents; vegetation; and mountain barriers. These influences usually work in combination to produce their climatic effects.

4. A *climate graph* is a convenient way of summarizing the elements of temperature and precipitation at a given place or station. From such a graph, we can usually determine *five things*:
   - *Total yearly precipitation*, usually stated on graph.
   - *Seasonal distribution of precipitation* tells us *when* the precipitation falls. Some of the possibilities:
     a. *Even distribution*–roughly the same amount of precipitation every month.
     b. *Summer maximum*–precipitation in every month, but an extra amount in summer.
     c. *Dry all year*–negligible precipitation every month.
     d. *Winter dry/summer wet*–negligible precipitation in winter.
     e. *Summer dry/winter wet*–negligible precipitation in summer.
   - *Average yearly temperature*–instead of totalling the temperatures for 12 months to take an average, it is simpler to take a rough approach and to cut the temperature curve into halves with a ruler or the eye. Alternatively, one could get a rough figure by averaging the hottest and coldest months.
   - *Temperature range* is a measure of the "bend" in a temperature curve, obtained by subtracting the temperature of the coldest month from the temperature of the hottest month.
   - *Growing season* is the number of months that have a temperature above 8.5°C (the temperature at which seeds begin to germinate).

Pressure and winds

5. *Wind* is the horizontal movement of air.

6. Air *moves* because of a difference in pressure between two points on the earth's surface. Air moves from a high-pressure zone to a low-pressure zone.

7. Differences in air pressure occur because of the unequal heating of the earth's surface. This unequal heating results from:
   - differences in latitude, with the sun's rays increasing in directness and power toward the tropics and decreasing in power toward the poles.
   - both land and water on the earth's surface, which warm up and cool off at different rates.

8. a. Horizontal movement of air is *wind*.
   b. Vertical movement of air is *convection*.

9. Refer to a suitable science book for examples.

Precipitation

11. When a substance (solute), dissolved in a solvent, comes out of solution, it is said to precipitate. The water vapor (solute), dissolved in air (the solvent), comes out of solution when air is cooled sufficiently. The result is *precipitation*.

12. All precipitation requires that air be made to rise and cool to the point where some of its invisible, dissolved water vapor will come out of solution into such visible forms as cloud, rain, snow, sleet, etc.

    Rising and cooling of air may come about in three ways:
    - Strong heating of the ground by the sun will produce a strong updraft or convection current of air. The end result is *convectional* rainfall.
    - Warm air may be forced to rise to get over a physical obstacle such as a mountain range. Such circumstances produce *orographic* or *relief* rainfall.

- Instead of a relief barrier, the obstacle may be a "mountain" of cold air, which, being colder, undercuts warmer air, forcing it to rise, thus producing *frontal* or *cyclonic* rain.

Diagrams of these rainfall types are in some geography texts; for example, in *Latin American World*, on page 93.

13. The teacher can proceed through a process of elimination for many of his/her examples. Thus relief rain cannot occur where there are no hills or mountains. Cyclonic precipitation will not occur in polar regions where there are no contrasting warm-air masses.

14. See Figures 1, 2, and 3.

Notes

Figure 1

When students know that the differences of pressure (that cause winds) are, in part, due to unequal heating of the earth's surface, they readily appreciate the importance of latitude and the position of the sun.

The next task is to determine the position of the sun so as to predict the seasonal pressure at a given location.

From Figure 1, students will readily infer that the overhead sun takes six months to move from its June 21 position to its December 21 position and traverses an angular (latitudinal) distance of 23½° + 23½° or 47°. At this rate, the sun moves almost 8° per month, or roughly 2° per week.

If the sun is at 0° on September 21, one week later it will seem to be 2° further south, and one month later on October 21 it will seem to be at 8°S.

Figures 2 and 3

In building up these diagrams through questioning of the class, the teacher might:

- Review "high" as area of rising air, "low" as area of sinking air.
- Point out that a "high" does not move to a "low"; rather air moves from the edge of a "high" to a low in the same way that water flows from the top of a hill to its bottom.
- When the overhead sun is on the equator, the equatorial low is also on the equator. When the sun "moves" away from the equator, the low cannot move as quickly owing to *heat lag*. The teacher might point out that in the local region the hottest hour of a summer's day is usually mid-afternoon and not mid-day when the sun is at its highest position for the day. That is, "it takes time for things to warm up and cool off."
- In the equatorial low, convectionally rising air cools and "wants to sink, but is unable to go down the up-escalator. It therefore moves off to the north and south and starts to sink about 30° away from the up-escalator."

Figure 4

Figure 4 is a tabular-graphic summary of the learnings. The *Africa cross-section* in Figure 4 corresponds to line A-B of Figure 5.

15. Before doing this question, the students should examine Figure 5 in relation to Figures 3 and 4. Figure 5 will then be seen as a flat-map summary of their understandings in generalized form. At this juncture, question 15 is assigned. This task requires the reverse process of analysis to test the understandings of the generalizations that students have been able to make. A specimen Figure 6 (answer) in completed form is appended.

16. Analysis of a graph involves expressing this information contained in the graph in the terms discussed in question 4 above.

    Example: *Vancouver, B.C.*

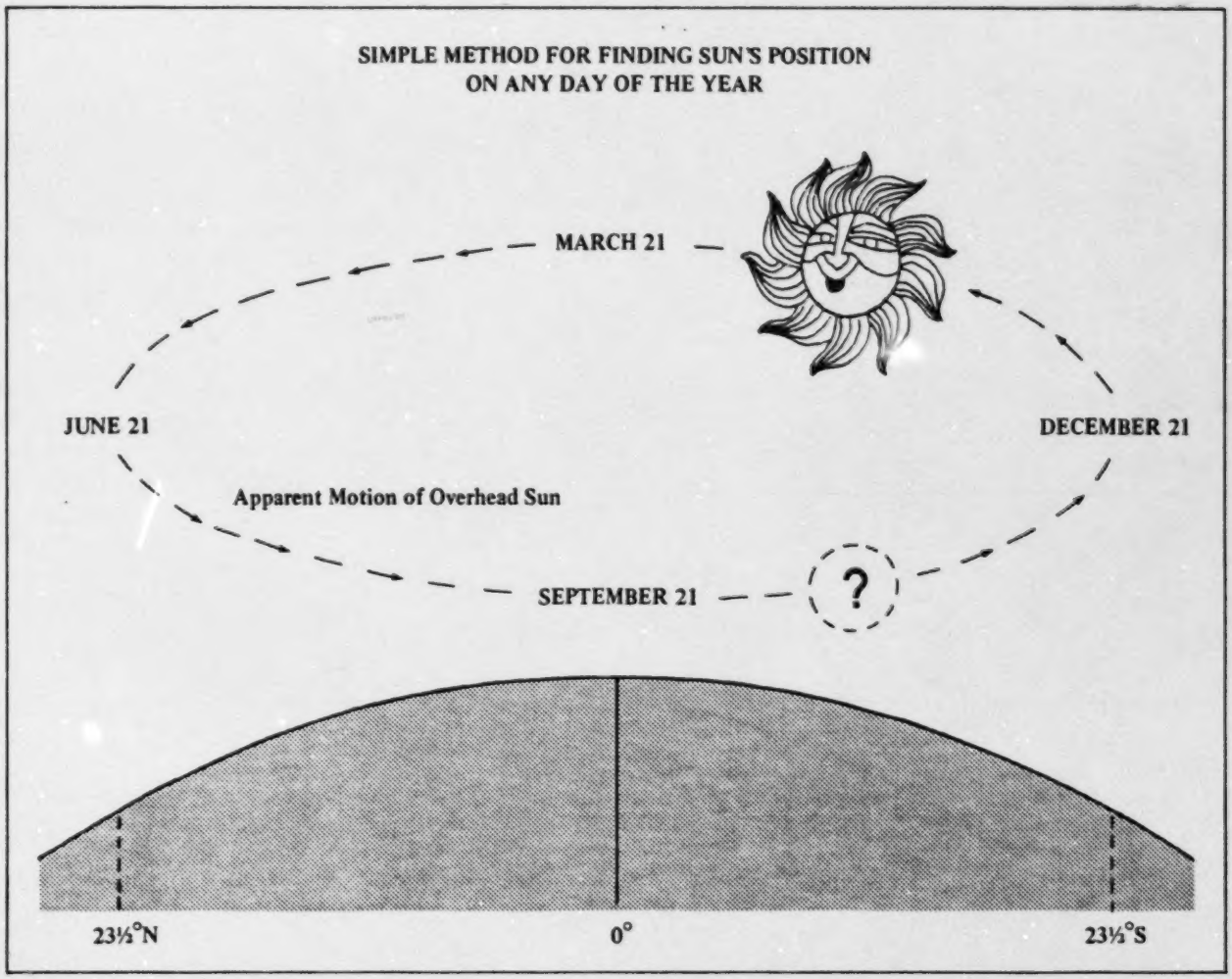
    Total precipitation = 144.27 cm
    Rain all year with winter maximum
    Average temperature about 12°C
    Temperature range = approximately 19.5°C to 4.5°C
    = 15C°
    Growing season is about 8 months

    The teacher might dwell on some peculiarities of the graphs given in question 16.

    - Why are some curves steep and others gentle?
    - Curve b has a very low range and is probably near the equator. It has a low average temperature because of high altitude.
    - Why does curve g have a double maximum in curve and rainfall?
    - Why does curve f take a downward dip in our summer months?
    - Why do the various stations set their rain in the amounts and distribution indicated?

17. *Graph matching climatic type*
    a. Hot wet all year, equatorial.
    b. Equatorial, at high altitude.
    c. Extreme continental.
    d. Wet all year, summer maximum, maritime.
    e. Evenly distributed, continental.
    f. Southern hemisphere, winter maximum.
    g. Maximum, spring and fall.
    h. Mediterranean, summer dry/winter wet.

FIGURE 1



Socratic reasoning from diagram above

a. For the sun to move from 23½°N to 23½°S requires _____ months.

b. In this time-distance of _____ months, the sun has moved through _____° + _____° or _____° of latitude; that is, an angular distance of _____°. (These numbers are not signed as to N or S. Why?)

c. In one month, the sun moves $\frac{?^\circ}{\text{answer in a.}}$ = _____° (to the nearest whole number).

d. In one week, the sun moves $\frac{\quad^\circ}{4}$ or _____° approximately (to the nearest whole number).

Applications

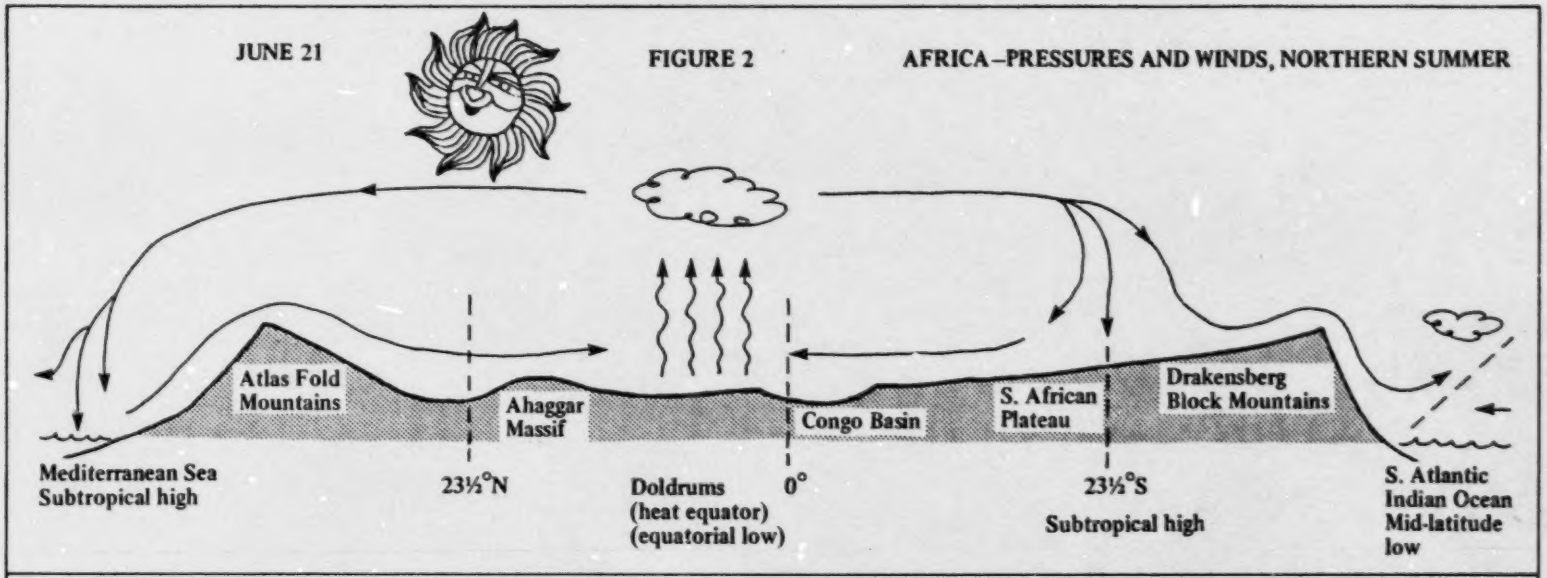
Why do we speak of the "apparent" motion of the sun?

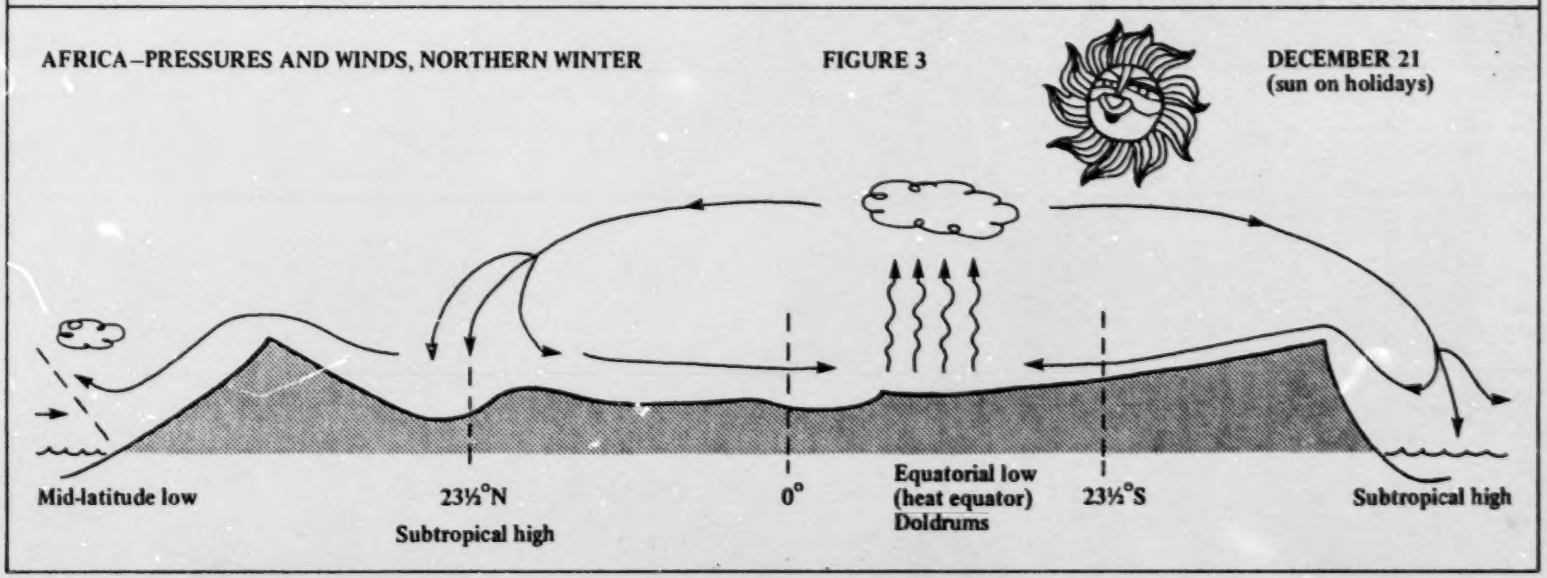
The sun in the diagram above is shown in its February 21 position. What is the latitude of its most direct ray? (At what latitude will it appear to be directly overhead? Or in the zenith?–for a very advanced class.)

At what other date in the year will the sun return to its February 21 position?

Application to climate–relate this notion to that of *dual rainfall peaks* for certain climatic stations indicated in atlas–allowing for time lag.

Where is the overhead sun today?



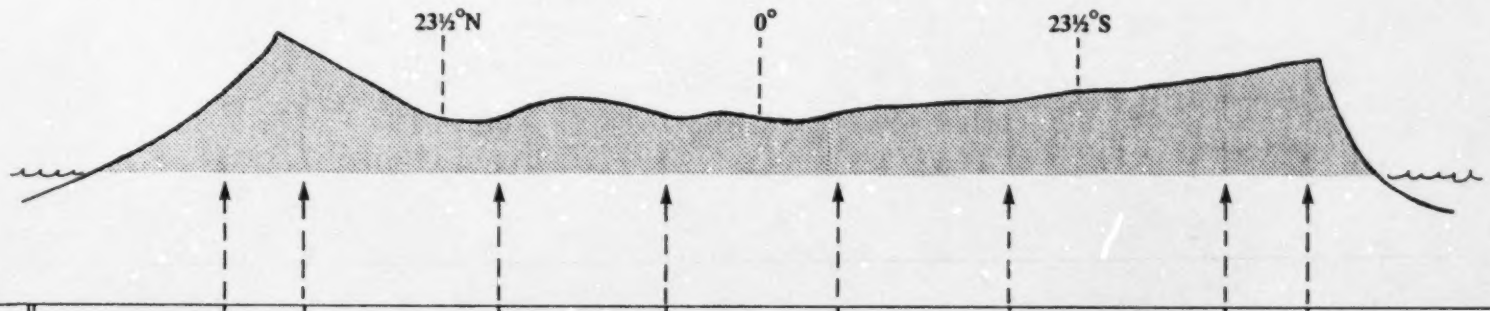


Methodology

Teacher puts skeleton cross-section on blackboard, then elicits data from the class to build the diagrams. The student assignment is to label and explain.

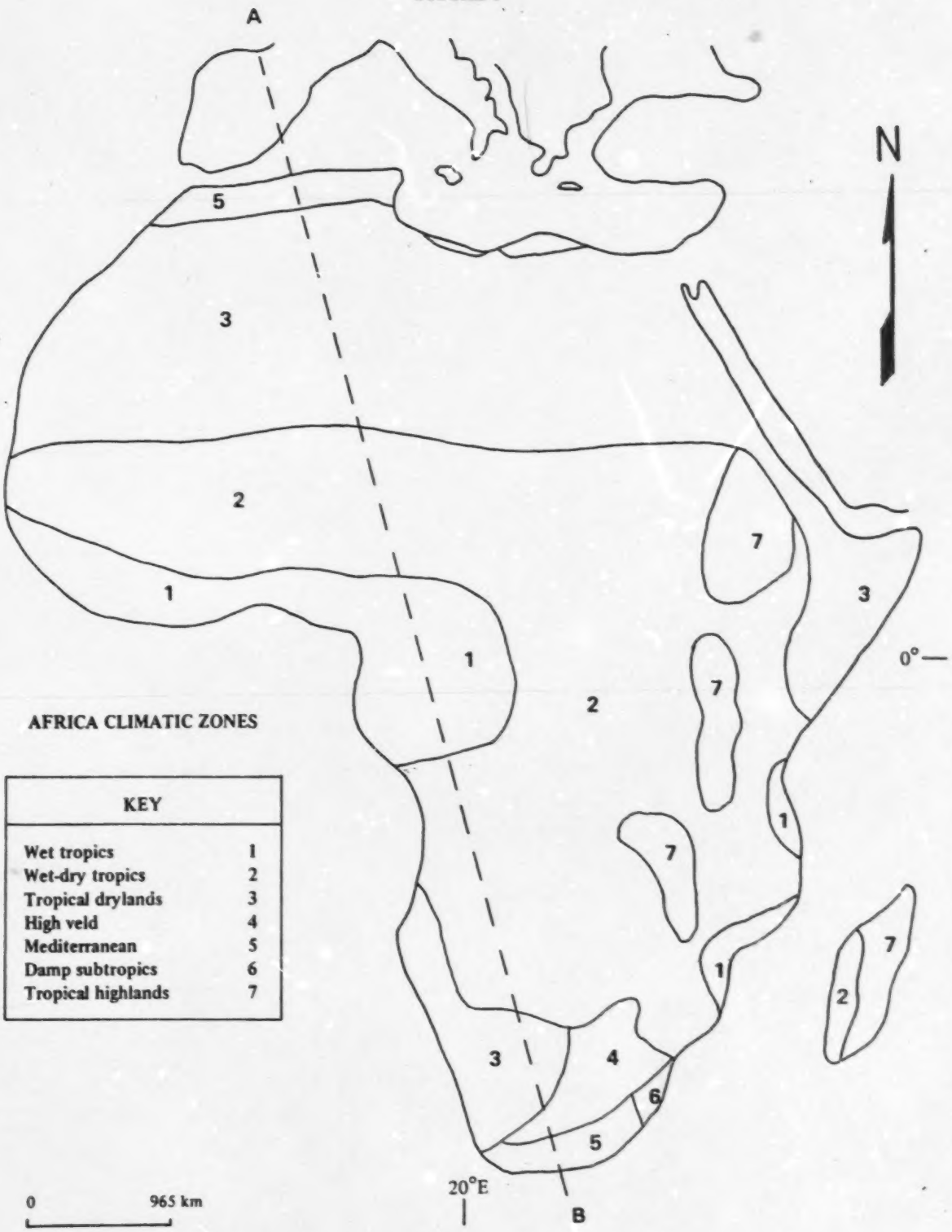
FIGURE 4

CLIMATE OF AFRICA
Characteristics (A), Factors (B), and Type/Names (C)



A	Dry summers Wet winters		Hot and dry all year	Wet summers Dry winters	Hot and wet all year	Wet summer Dry winter	Hot and dry Atlantic coast. Warm temperate on interior plateau, with rain coming in summer		Dry summer Wet winter
B	Summer high therefore dry. Winter low over water and coast pulls in Westerlies → cyclonic rain.		Summer low, but incoming winds (trades) have not passed over significant moisture and are dry. Winter high therefore dry.	Summer low convectional rain. Winter high therefore dry.	Sun overhead more or less all year therefore low and convectional rain all year.	Summer low convectional rain. Winter high therefore dry.	Rainshadow of SE trades. Cold Benguela current chills winds, which are later warmed up by warmer coast so as to pick up moisture. Higher elevations are cooler, less evaporation therefore greater moisture effectiveness when it is available.		Summer, subtropical. High over water and coast therefore dry. Winter low Westerlies → cyclonic rain.
C	Mediterranean		Tropical dryland (desert)	Wet-dry tropics	Equatorial (hot-wet tropics)	Wet-dry tropics	Tropical dryland or desert on Atlantic coast. Wet-dry warm temperate interior.		Mediterranean

FIGURE 5



AFRICA CLIMATIC ZONES

KEY	
Wet tropics	1
Wet-dry tropics	2
Tropical drylands	3
High veld	4
Mediterranean	5
Damp subtropics	6
Tropical highlands	7

FIGURE 6 (ANSWER)

CLIMATE ZONES–AFRICA

Climatic region	Characteristics Temperature/precipitation	Reasons for these characteristics	Representative station
Hot-wet tropics	High average temperature 24.5°C. Low temperature range (4°-5°F). Rain in every month, with maxima when sun is overhead directly. High total rainfall 152 cm to 254 cm.	Near equator; lowland. Always more or less under the direct sun; therefore, low pressure → convectional rain all year.	Douala, Cameroon
Wet-dry tropics	High average temperature, but not as high as wet tropics. Temperature range slightly higher (8°+F). Rain mostly in hot months. Dry winters.	Farther from equator, but still in or near tropics. Definite period when sun is not overhead. Summer → low → rain. Winter → high → dry.	Freetown, Sierra Leone
Tropical drylands	Less than 25 cm rain/year. Temperature range 15°+F. Average temperature lower than in wet tropics or wet-dry tropics.	Winter: high → dry. Summer: low → winds are dry.* Farther from equator. **summer*–Sahara Desert: low, NE trades blow in from land and are dry–Namib Desert (S. Africa), Rainshadow of SE trades. Cold Benguela current cools winds from Atlantic.	Tamanrasset, Algeria
Mediterranean	Hot, dry summers. Cool, wet winters. Average temperature 17°C. Temperature range 15°F or more.	High over water, affects coast → dry (summer). Low over water, affects coast → wet (winter). Farther from equator.	Algiers, Algeria
Tropical highland	Lower average temperature. Low temperature range (60°F more or less). Moisture variable.	Due to elevation. Near equator. May be relief rain or rainshadow depending on location.	Addis Ababa, Ethiopia
Veld	20" to 40" of rain, mostly summer. July is winter month. Temperature range about 15°F. Average temperature 17°C.	Winter → high; summer → low. Veld is south of equator. Some distance from equator. Altitude.	Johannesburg, Republic of South Africa
Damp subtropics	High total rainfall, summer maximum. Temperature range about 15°F. July is winter month.	Relief rain, ← SE trades on SE coast of Africa. Not quite "tropical" (outside of tropics). This climate type is south of equator.	Durban, Republic of South Africa

At this juncture, students will have a working idea of *climatic regions* in their dynamic interplay of climatic factors. They will realize that such regions are *single-factor regions*; that is, areas of the earth's surface that are more or less uniform in one respect or factor—in this instance that of climate.

If climate is subdivided into precipitation and temperature, a scrutiny of any good atlas will disclose that temperature regions and rainfall regions are not congruent. That is all to the good, since the conjoined influence of temperature and rainfall is of greater import to human life.

Similarly the conjoined influence of climate, vegetation, soils and landforms produces the *multi-factor regions* known as *natural regions*. These are the most logical areal units for describing the natural habitats in which the various peoples of this planet live.